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Safety of Cystic Duct Clipping in Healthy and Cirrhotic Livers: A Cadaveric Study

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ABSTRACT

Background and Objectives: Biliary leakage through the cystic duct stump due to clip dislodgement has been a concern since the advent of the laparoscopic cholecystectomy. The authors proposed a cadaveric model to test the safety of cystic duct clipping in a hypertensive biliary tract in healthy and cirrhotic livers.

Methods: Twenty fresh cadavers were studied (5 cirrhotic, 15 healthy). Open cholecystectomy was performed and the cystic duct clipped with commercially available titanium clips. The distal common bile duct was catheterized to allow infusion of water and pressure measurement.

Results: Increased pressure in the bile duct resulted in back diffusion into the liver, preventing reaching high-pressure levels. Only 1 clip was dislodged in this situation, in a cirrhotic liver with a large cystic duct. As a second experiment, the hepatic hilum was clamped to allow higher pressures of the biliary tree (500 mm Hg). In this situation, no clip was dislodged.

Conclusions: We have established the safety of cystic duct clipping in healthy and cirrhotic livers; however, bigger clips or alternative methods to seal the duct may be necessary in larger ducts.

Key Words: Cholecystectomy, Laparoscopy, Cirrhosis, Clip.

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INTRODUCTION

Laparoscopic cholecystectomy (LC) is one of the most performed operations in general surgery. Several methods have been developed to seal the cystic stump after LC;[1,2] however, metallic clips are usually the method used. Clip dislodgment, although rare, has been a concern since the advent of LC.

Although some experiments to evaluate safety of cystic duct clipping were previously carried out,[3-5] a cadaveric model has never been used and healthy livers have not been compared with cirrhotic ones.

METHODS

Twenty fresh cadavers (death time less than 6 hours) autopsied at the São Paulo Medical Examiner's Office were studied. Fifteen cadavers had a healthy liver (13 men, mean age 45.3), and 5 had a cirrhotic liver (4 men, mean age 64.0 years). Victims of abdominal trauma or those likely to have abdominal diseases (except cirrhosis) were excluded from the study.

Open cholecystectomy was performed and the cystic duct was clipped with a single commercially available titanium clip (LT-300, medium/large, Ethicon, Inc, Cincinnati, OH) with the aid of a disposable clip applier (10 mm, Ethicon, Inc, Cincinnati, OH), 1 cm distal to its insertion in the common bile duct. Division of the cystic duct was done close to the clip.

The distal common bile duct was catheterized with an apparatus consisting of a t tube connected to a pressure transducer and a syringe.

In the first part of the experiment, water was injected into the biliary tree until clip dislodgment or infusion of 300 mL of water. Maximum pressure was recorded. In the second part of the experiment, hepatic hilum was clamped to allow higher pressures of the biliary tree. Water was infused until clip dislodgement or the threshold of 500 mm Hg of pressure.

RESULTS

In the first part of the experiment, increased pressure in the bile duct resulted in back diffusion of the water into the liver (water enters the liver parenchyma, causes it to swell, and leaks through the capsule) before sufficient pressure within the bile duct caused a clip to dislodge. Mean maximum pressures recorded were 70.3 mm Hg (range, 20 to 200) for healthy livers and 68.5 (range, 40 to 112) mm Hg for cirrhotic livers (not statistically significant. P= 0.94, Student t test).

In 1 cadaver with a cirrhotic liver, the clip was dislodged at a pressure of 150 mm Hg. Although, the biliary tree was normal in all cases, this cadaver had a larger cystic duct than did the others (8 mm).

In the second part of the experiment, pressure reached 500 mm Hg in all cases and no clip was dislodged.

DISCUSSION

Clip dislodgement after LC is a reality, with several cases being reported.[6,7] An index of 0.1% to 2% of postoperative bile leak through the cystic duct is estimated after LC **(Table 1)**.

Three previous reports[3-5] evaluated experimentally the safety of cystic duct clipping in a hypertensive biliary tract. In an ex vivo model, clips applied to human gallbladder's attached cystic ducts were not dislodged by pressures lower than 300 mm Hg.[3,4] In animal models,[3-5] clips were also safely intact despite a high intraluminal pressure. As far as we know, the use of a cadaveric model and the comparison of normal and cirrhotic livers are original to our study.

Table 1.
Incidence of Biliary Leakage Through Cystic Duct After Laparoscopy Cholecystectomy, as Reported in the Literature

Author	% Biliary Leakage
Chen et al[8]	0.07
Sefr et al[9]	0.08
Huang et al[10]	0.11
DeMar and Gruenberg[11]	0.16
Kaushik et al[12]	0.16
Miroshnik et al[13]	0.25
Wise Unger et al[14]	0.26
Bailey et al[15]	0.27
Nottle[16]	0.32
Chan et al[17]	0.33
Jan et al[18]	0.45
Kozarek et al[19]	0.50
Peters et al[20]	0.58
Tagle et al[21]	1.1
Adamsen et al[22]	1.5
Sugiyama et al[23]	2.06
Mean	0.51

We tried to simulate in cadavers the same condition present in vivo. Our first attempt mimicking a distal obstruction was to open the duodenum, suture the papilla, record pressure, and inject bile collected from other cadavers (to keep the same viscosity and density of bile) by puncture. However, first, an uncontrollable leak occurred in the puncture point requiring us to catheterize the common bile duct; and, second, the large volume of bile necessary to raise the pressure (300 mL) prevents the use of bile.

The significance of the back diffusion of the water into the liver is not known. We are not sure whether this would apply or have any importance in the living state.

LC is increasingly being performed in cirrhotic patients.[24] One would expect a higher index of clip dislodgment in cirrhosis due to the lesser compliance of the cirrhotic liver, allowing higher pressures in the biliary tract. However, no cases of clip displacement occurred in cirrhotic patients, and the maximum pressures obtained in our experiments were similar between healthy and cirrhotic livers.

Our experiment confirmed the safety of cystic duct clipping in a cadaveric model. Clinical cases of clip dislodgement may be influenced by other factors like necrosis of the cystic stump, misplacement of the clip, and conduction injury.[4,25] Bigger clips or alternative methods to seal the duct may be necessary in larger ducts.

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